UNITED STATES

TITLE: IMPROVED RAM PUMP

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FIELD OF THE INVENTION

[0001] The present invention relates to the field of hydraulic ram pumps.

BACKGROUND OF THE INVENTION

[0002] Hydraulic ram pumps, also called water rams or ram pumps, are well-known devices that, using only a source of flowing fluid, can pump said fluid at relatively high pressure. However, known ram pumps can suffer from the need to utilize a large number of precision parts in the valving areas, at commensurate costs, in order to provide reliable, efficient pumping. There is a need for a relatively efficient and reliable hydraulic ram pump that is relatively inexpensive to construct.

SUMMARY OF THE INVENTION

[0003] In accordance with the present invention there is disclosed an improved ram pump for use with a fluid source having an initial head. The ram pump is of the generally known type that has an intake manifold engagable with the fluid source, the intake

manifold defining a waste outlet and a pump outlet therethrough. The ram pump is also of the generally known type that has a waste valve member selectively moveable between a waste configuration whereat the fluid source is flowable through the waste outlet and a closed configuration whereat the waste valve member sealingly obstructs flow of the fluid source through the waste outlet. Further, the ram pump is of the generally known type that has a check valve member selectively moveable between a ram configuration whereat the check valve member substantially obstructs flow of the fluid source through the pump outlet and a pump configuration whereat the fluid source is flowable through the pump outlet. The ram pump is of the type that is generally known to urge the waste valve member towards the closed configuration when the check valve member is in the ram configuration and the waste valve member is in the waste configuration, and when the fluid source is at a first maximum head. The ram pump is also of the type that is generally known to urge the check valve member towards the pump configuration when the waste valve member is in the closed configuration and the check valve member is in the ram configuration, and when the fluid source is at a second maximum head. The ram pump is still further of the type that is generally known to urge the waste valve member towards the waste configuration when the check valve member is in the pump configuration and the waste valve member is in the closed configuration, and when the fluid source is at a first minimum

head. The ram pump is yet further of the type that is generally known to urge the check valve member towards the ram configuration when the waste valve member is in the waste configuration and the check valve member is in the pump configuration, and when the fluid source is at a second minimum head. In accordance with the present invention, the improvement comprises the waste valve member being selectively moveable along a path having a vertical component between the default waste configuration and the closed configuration, with the waste valve member being gravity-biased towards the default waste configuration. The check valve member is selectively moveable along a substantially horizontal path between the ram configuration and the pump configuration, with the check valve member being biased towards the ram configuration, wherein the fluid source is substantially horizontally flowable through the pump outlet when the check valve member is in the pump configuration.

[0004] According to a further aspect of the invention, a tubular skirt portion extends in a substantially downward direction from a peripheral portion of the waste valve member.

[0005] According to another aspect of the invention, the path having a vertical component comprises a substantially vertical axis.

[0006] According to a still further aspect of the invention, the intake manifold includes a waste valve body and a manifold casing engagable with the fluid source. The manifold casing securely engages a lower end portion of the waste valve body. The waste valve body defines in throughpassing relation a waste conduit extending between the lower end portion and an upper end portion of the waste valve body. The waste conduit is in fluid communication with the manifold casing substantially adjacent to the lower end portion and in fluid communication with the waste outlet substantially adjacent to the upper end portion of the waste valve body. The waste valve body includes an upper bearing mounted substantially adjacent to the upper end portion and a lower bearing mounted substantially adjacent to the lower end portion. A longitudinal upper piston portion of the waste valve member extends in a substantially upward direction from a central portion of the waste valve member and engages the upper bearing in throughpassing slidable relation. A longitudinal lower piston portion of the waste valve member extends in the substantially downward direction from the central portion of the waste valve member and engages the lower bearing in throughpassing slidable relation.

[0007] According to yet another aspect of the invention, a peripheral cushioning member extends transversely from the

longitudinal upper piston portion. The peripheral cushioning member selectively engages the upper bearing when the waste valve member is in the default waste configuration.

[0008] According to a yet further aspect of the preferred embodiment of the invention, the substantially horizontal path comprises a substantially horizontal axis.

[0009] According to another aspect of the preferred embodiment of the invention, the fluid source is substantially unobstructed by the check valve body when the check valve member is in the pump configuration.

[0010] According to yet still another aspect of the preferred embodiment of the invention, the fluid source is flowable through the pump outlet into a pressure vessel when the check valve member is in the pump configuration. The pressure vessel defines a vessel outlet and contains a substantially impermeable bladder membrane that is remotely positioned relative to both the pump outlet and the vessel outlet respectively. The bladder membrane encloses a buffer fluid that is elastically pressurized when the check valve member is in the pump configuration.

[0011] According to a further aspect of the preferred embodiment of the invention, the manifold casing, the check valve body, and the waste valve body are each respectively constructed from conventional valving mechanisms.

[0012] Other advantages, features and characteristics of the present invention, as well as methods of operation and functions of the related elements of the structure, and the combination of parts and economies of manufacture, will become more apparent upon consideration of the following detailed description with reference to the accompanying illustrations, the latter of which is briefly described hereinbelow.

BRIEF DESCRIPTION OF THE FIGURES

[0013] In the accompanying Figures, which should be expressly understood to be for the purpose of illustration and description only, and are not intended as a definition of the limits of the invention:

[0014] **Figure 1** is a side elevational view of an improved ram pump according to a preferred embodiment of the invention showing,

in phantom outline, the bladder membrane inside the pressure vessel.

[0015] **Figure 2** is a partially exploded view of the structure of Figure 1;

[0016] **Figure 3** is an enlarged view of the waste valve body of Figure 2 showing, in phantom outline, the waste valve member in the waste configuration;

[0017] **Figure 4** is a partially sectional view along sight line 4-4 of Figure 3 with the waste valve member in the closed configuration;

[0018] **Figure 5** is an enlarged sectional view of the check valve member of Figure 2 shown in the ram configuration;

[0019] **Figure 6** is an enlarged sectional view of the check valve member of Figure 2 shown in the pump configuration;

[0020] **Figure 7** is a front, bottom perspective partial view of the waste valve member of Figure 4;

[0021] **Figure 8** is a front, bottom perspective view of an extender according to a preferred embodiment of the invention; and

[0022] **Figure 9** is a view of the extender of Figure 8, in use with the pump of Figure 1.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[0023] Referring now to Figure 1, there is shown an improved ram pump 20 for use with a fluid source (not shown) having an initial head. The ram pump 20 is of a type that has an intake manifold 22 engagable with the fluid source. The intake manifold 22 defines a waste outlet 36 and a threaded pump outlet 24 therethrough.

[0024] The ram pump 20 also includes a waste valve member 42 that is selectively moveable between a waste configuration whereat the fluid source is flowable through the waste outlet 36 (as best seen in Figure 3) and a closed configuration whereat the waste valve member 42 sealingly obstructs flow of the fluid source through the waste outlet 36 (as best seen in Figure 4).

[0025] Further, the ram pump 20 also includes a check valve member 54 that is selectively moveable between a ram configuration

whereat the check valve member 54 substantially obstructs flow of the fluid source through the pump outlet 24 (as best seen in Figure 5) and a pump configuration whereat the fluid source is flowable through the pump outlet 24 (as best seen in Figure 6).

[0026] As best seen in Figures 1, 2 and 6, the fluid source is flowable through the pump outlet 24 into a pressure vessel 70 when the check valve member 54 is in the pump configuration. The pressure vessel 70 includes a vessel cap member 78 and a hollow vessel body 80 that defines a threaded vessel outlet 72. The hollow vessel body 80 has a closed end 82 and an open end 84 and is in fluid communication with the vessel outlet 72 which is intermediate the closed end 82 and the open end 84. The vessel cap member 78 sealingly and threadingly engages the open end 84 of the vessel body 80, and in this regard, the open end 84 of the hollow vessel body 80 is provided with threads 86 to sealingly engage, in use, corresponding threads 88 provided on the vessel cap member 78. The vessel cap member 78 has a vessel inlet 79 formed therethrough, and is rigidly connected, by welding or the like, to the manifold casing 26. The vessel inlet 79 of the vessel cap member 78 and the pump outlet 24 of the manifold casing 26 are in fluid communication with one another.

[0027] The pressure vessel 70 contains a substantially impermeable bladder membrane 74 that is positioned within the vessel body 80 adjacent the closed end 82 and remotely positioned relative to both the pump outlet 24 and the vessel outlet 72 respectively. The bladder membrane 74 encloses a buffer fluid 76 that is elastically pressurized when the check valve member 54 is in the pump configuration. The bladder membrane 74, which is constructed from rubber or a similar elastic material, may be filled with air or any other elastically pressurizable fluid.

[0028] The intake manifold 22 includes a tubular waste valve body 28 and a manifold casing 26 that is engagable with the fluid source adjacent a threaded supply inlet 27A thereof. The manifold casing 26 is in fluid communication with the pump outlet 24 of the intake manifold 22 and has a threaded waste body port 27B. The manifold casing 26, as shown in the figures, may be formed from a conventional 2" tee fitting, constructed out of 316-1 stainless steel and having a 1/4" wall thickness.

[0029] The threaded waste body port 27B of the manifold casing 26 securely, sealingly and threadingly engages a lower end portion 30 of the waste valve body 28. The waste valve body 28 defines in throughpassing relation a waste conduit 32 extending between the lower end portion 30 and an upper end portion 34 of the waste valve

body 28. The waste conduit 32 is in fluid communication with the manifold casing 26 substantially adjacent to the lower end portion 30 and in fluid communication with the waste outlet 36 substantially adjacent to the upper end portion 34 of the waste valve body 28. The waste valve body 28 also defines a constricted portion 33 of the waste conduit 32 that is intermediate of the lower end portion 30 and the waste outlet 36, and has a smaller cross-sectional area than some other portions of the waste conduit 32. The constricted portion 33 has a seat portion 33A.

[0030] The waste valve body also includes an upper bearing 38 rigidly mounted, by welding or the like, substantially adjacent to the upper end portion 34 and a lower bearing 40 rigidly mounted, by welding or the like, substantially adjacent to the lower end portion 30. A longitudinal upper piston portion 50 of the waste valve member 42 extends in a substantially upward direction "D" from a central portion 48 of the waste valve member 42. The longitudinal upper piston portion 50 extends through the constricted portion 33 of the waste conduit 32, through the waste outlet 36, and engages the upper bearing 38 in throughpassing slidable relation. The upper piston portion 50 has a threaded upper end portion 51. A longitudinal lower piston portion 52 of the waste valve member 42 extends in the substantially downward direction "C" from the central portion 48 of the waste valve member

42. The longitudinal lower piston portion 52 engages the lower bearing 40 in throughpassing slidable relation. The upper and lower piston portions, 50 and 52, move with the waste valve member 42 between the waste and the closed configurations.

[0031] A peripheral cushioning member 60 extends transversely from the longitudinal upper piston portion 50. The peripheral cushioning member 60 includes a conventional nut or fastening member 62 threadingly engaging the threaded upper end portion 51 of the upper piston portion 50 of the waste valve member 42. The peripheral cushioning member 60 also includes a compressible pad member 64 positioned about the upper piston portion 50 and securely engaging the fastening member 62. A reinforcing ring member 66 securely engages the compressible pad member 64 in circumferential relation.

[0032] As best seen in Figures 3 and 4, the waste valve member 42 is selectively moveable, in use, along a path having a vertical component, and preferably along a substantially vertical axis A-A, between the default waste configuration and the closed configuration, such that the waste valve member 42 is gravity-biased towards the lower end portion 30 of the waste valve body 28 and towards the default waste configuration. As best shown in Figure 3, the peripheral cushioning member 60, and more

specifically the compressible pad member 64, selectively engages the upper bearing 38 when the waste valve member 42 is in the default waste configuration.

[0033] As best seen in Figure 7, a tubular skirt portion 46 extends in a substantially downward direction "C" from a peripheral portion 44 of the waste valve member 42. The tubular skirt portion 46 has a circumference slightly smaller than the base of the peripheral portion 44, and slightly larger than the constricted portion 33. As best shown in Figure 4, the peripheral portion 44 securely engages a peripheral O-ring member 45 that sealingly engages the seat portion 33A when the waste valve member 42 is in the closed configuration.

[0034] It will be appreciated by persons of ordinary skill in the art that the waste valve body 28 and the waste valve member 42, as best seen in Figures 3 and 4, may together be constructed from a 1 1/2" nominal OD threaded coupling 100 and a conventional 1 1/4" stainless steel gravity-biased check valve 102, modified as follows: in the provision of the skirt portion 46; in the placement of the bearings 38, 40; in the provision of the cushioning member 60; and in the provision of the constricted portion 33.

[0035] As best seen in Figures 5 and 6, the check valve member 54 is selectively moveable, in use, along a substantially horizontal path, and preferably along a substantially horizontal axis B-B, between the ram configuration and the pump configuration. The check valve member 54 is spring biased towards the ram configuration by a spring member 58C. The check valve member 54 also includes a check valve body 56 and a valve cap member 58. The spring member 58C is mounted to the check valve body 56 and to the valve cap member 58 to bias the valve cap member 58 for movement towards the ram configuration.

[0036] The check valve body 56 has a downstream end 57B, an internally threaded portion 57A, and a threaded check valve coupling 55 sealingly, threadingly engaged within the internally threaded portion 57A of the check valve body 56. The check valve body 56 has a check valve seat 59 formed therein, substantially adjacent to the downstream end 57B. The valve cap member 58 has a valve cap 58A and a stem 58B, and is mounted to the check valve body 56. In use, the valve cap member 58 moves along the substantially horizontal axis B-B between the ram configuration whereat the valve cap 58A rests on the check valve seat 59 to substantially obstruct flow of the fluid source through the pump outlet 24 and the downstream end 56B of the check valve body 56, as best seen in Figure 5, and the pump configuration whereat the valve

cap 58A is disposed apart from the check valve seat 59 to permit substantially unobstructed fluid flow through the check valve member 54, as best seen in Figure 6.

[0037] In use, the check valve member 54 is disposed within the pressure vessel 70. The threaded check valve coupling 55 extends from the internally threaded portion 57A, through the vessel inlet 79 of the vessel cap member 78, to securely, sealingly and threadingly engage the pump outlet 24 of the manifold casing 26. It will be noted that the check valve member 54 of the preferred embodiment may be formed from a conventional 1 1/4" check valve, constructed of stainless steel, modified only by the removal of a tubular portion which, as purchased, extends slightly beyond the valve cap 70 when seated, so as to shield the same when in the check valve member is in the pump configuration. With this modification, and as best seen in Figure 6, the fluid source is substantially horizontally flowable through the pump outlet 24, and substantially unobstructed by the check valve body 56, when the check valve member 54 is in the pump configuration.

[0038] As such, it will be appreciated from the foregoing that the manifold casing 26, the check valve body 54, and the waste valve body 28 may each respectively be constructed from conventional valving mechanisms.

[0039] In use, the supply inlet 27 of the manifold casing 26 is coupled to the fluid source (not shown), so as to permit flowing water or some other fluid to enter the manifold casing 26 through the supply inlet 27. The valve cap member 58 of the check valve member 54, being biased as aforementioned towards the ram configuration, substantially obstructs the flow of fluid into the pressure vessel 70, causing fluid to instead flow into the waste valve body 28, around the waste valve member 42, which is initially positioned in the waste configuration as shown in Figure 3, and out of the waste outlet 36. The ram pump 20 is of a type that urges the waste valve member 42 towards the closed configuration when the check valve member 54 is in the ram configuration and the waste valve member 42 is in the waste configuration, and when the fluid source is at a first maximum head, namely, when the fluid source reaches a certain maximum speed through the waste outlet 36 sufficient to overcome the gravity-biasing of the waste valve member 42 towards the waste configuration. That is, the flowing force of said fluid source ultimately (i.e., at the first maximum head) drags the waste valve member 42 to the closed configuration, as best seen in Figure 4, to sealingly obstruct flow through the waste outlet 36.

[0040] Thereafter, the momentum of the flowing water (a "water hammer") from the fluid source causes a temporary increase in pressure within the manifold casing 26 to reach a second maximum head that is sufficient to overcome the bias of the spring member 58C and permit a charge of water to enter the pressure vessel 70, and to elastically pressurize the air or other fluid contained within the bladder membrane 74. That is, the check valve member 54 is urged towards the pump configuration when the waste valve member 42 is in the closed configuration and the check valve member 54 is in the ram configuration, and when the fluid source is at the second maximum head.

[0041] Next, at a first minimum head, once the pressure between the manifold casing 26 and the pressure vessel 70 has substantially equalized, the waste valve member 42 tends to move, under force of gravity, away from the closed configuration and towards the waste configuration, as best seen in Figure 3, since any drag forces (at the first maximum head) which may have previously caused it to move towards the closed configuration have dissipated and no longer exist, such that flow can again occur through the waste valve body 28. To put it another way, the ram pump 20 urges the waste valve member 42 towards the waste configuration when the check valve member 54 is in the pump configuration and the waste valve member

42 is in the closed configuration, and when the fluid source is at the first minimum head.

[0042] To complete the cycle, the check valve member 54 is urged towards the ram configuration when the waste valve member 42 is in the waste configuration and the check valve member 54 is in the pump configuration, and when the fluid source is at a second minimum head. That is, flow of the fluid source through the waste outlet 36 results in insufficient pressure within the manifold casing 26 to continue to resist the spring-biasing of the check valve member 54 towards the ram configuration, and therefore, the valve cap 70 in the check valve member 54 naturally returns to the ram configuration, thereby substantially obstructing further flow between the manifold casing 26 and the pressure vessel 70.

[0043] Over time, and with repeated cycles of the improved ram pump 20 as aforesaid, pressure in the air or other fluid contained within the bladder membrane 74, and pressure on any water or other fluid within the pressure vessel 70, will build until it is sufficient to expel such water or other fluid through the vessel outlet 72 against any stationary head that may exist, or until it matches the instantaneous pressure created by the water hammer. The pressure in the buffer fluid 76 may also act as a steady exhausting force to remove fluid from the vessel body 80 at a

substantially more uniform rate than any rate at which it may be supplied from the manifold casing 26 through the pump outlet 24. That is, an intermittent flow of fluid may be converted by the bladder membrane 74 and the buffer fluid 76 into a more uniform and constant stream.

[0044] Depending, *inter alia*, upon the initial head of the water supplied to the supply inlet 27, and the stationary head which needs to be overcome before water or other fluid can be expelled through the vessel outlet 72, adjustments to a stroke length and/or to an effective weight of the waste valve member 42, such as are known to persons of ordinary skill in the art, may need to be made to the ram pump 20. Adjustments to the stroke length can be achieved simply by manipulation of the fastening member 62 of the cushioning member 60, and sliding the pad member 64 and the reinforcing ring member 66 accordingly. Adjustments to the effective weight of the waste valve member 42 can be achieved by affixing a suitable weight to the threaded upper end portion 51 of the upper piston portion 50. Nuts, for example, could be used. However, in circumstances where the water or other fluid is delivered to the supply inlet 27 at a substantial initial head or pressure, substantial forces may need to be applied to the upper piston portion 50 in order to overcome same. In such case, relatively more massive objects need be used. For this purpose, an

extender 90, as illustrated in Figure 8, may be threaded onto the threaded upper end portion 51 of the upper piston portion 50 in the manner illustrated in Figure 9, to permit larger weights to be employed.

[0045] Without intending to be bound by theory, the relatively high efficiency of the present invention is obtained *inter alia* through the modification of the check valve member 54, as aforesaid, which is believed to improve flow characteristics between the manifold casing 26 and the pressure vessel 70; through the substantially horizontal orientation of the check valve member 54 along axis B-B; and through the provision of the skirt portion 46 and the constricted portion 33, which are believed to provide an advantageous swirling flow (not shown) in the waste valve body 28. Similarly, without intending to be bound by theory, the relatively high reliability of the present invention is obtained *inter alia* through the positioning of the upper and lower bearings 38, 40 and in the provision of the cushion member 60, which lessens the shock that would otherwise be placed on the waste valve member 42. The use of conventional valving mechanisms, in part, is responsible for the relatively low cost of the structure.

[0046] Of course, various modifications may be made to the present invention without departing from its spirit or scope.

Accordingly, the present invention should be understood as being limited only by the accompanying claims, purposively construed. An example of one such modification is the replacement of the vessel cap member 78 with a cap plate (not shown) that may be rigidly connected, by welding or the like, directly to the threaded check valve coupling 55. In such a modification, the cap plate and the vessel body 80 might also be adapted to securely and sealingly engage one another by way of a clamp member (not shown). Likewise, it will be appreciated that the vessel outlet 72, although shown in the accompanying figures to have a substantially vertical axis, may be oriented along an axis that does not even have a vertical component (i.e., that is horizontal). As well, and as best seen in Figure 4, the threaded coupling 100 may be provided with or without a constricted upper portion; such a constricted upper portion would serve to accelerate passage of the fluid source through the coupling 100. Another modification that is specifically contemplated by the invention, and one that may be of particular application *inter alia* where there is a low existing stationary head, is that of a ram pump 20 provided without a pressure vessel 70, that instead feeds fluid directly from the pump outlet 24 to an end user. In light of the various exemplary modifications and alterations outlined above which do not depart from the spirit or scope of the invention, it should once again be noted that the present invention is limited only by the accompanying claims.